

Observations on distribution and biology of *Galeus melastomus* (Chondrichthyes, Scyliorhinidae) in the southern Tyrrhenian Sea (central Mediterranean)

by

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ABSTRACT. - The blackmouth catshark *Galeus melastomus* Rafinesque, 1810 is commonly caught all along the southern Tyrrhenian Sea. The knowledge about the biology of this species is limited, especially in this area. Data collected from five trawl surveys carried out during spring 1999, 2000 and 2001 and autumn 2000 and 2001, are analysed in order to fill the gap of information about population structure, length-weight relationship, and reproductive biology of the blackmouth catshark in the studied area. On the whole, 1,046 specimens (537 males and 509 females) were caught between 300 and 700 m depth. The percentage of positive hauls (55%) is observed in the deepest strata (300-700 m). The length of the specimens ranged from 10 to 50 cm TL both for males and females. Young specimens represented the bulk of the catch. The length frequency distributions were plurimodal. However, some significant differences were observed in population composition according to depth and season. On the basis of weight-length relationship an isometric growth was observed.

RÉSUMÉ. - Observations sur la distribution et la biologie de *Galeus melastomus* (Chondrichthyes, Scyliorhinidae) en mer Tyrrhénienne méridionale (Méditerranée centrale).

Le chien espagnol *Galeus melastomus* Rafinesque, 1810, est couramment capturé en mer Tyrrhénienne méridionale. Nos connaissances sur la biologie de cette espèce sont fragmentaires, notamment dans cette zone. Des données récoltées lors de cinq campagnes de chalutage effectuées au printemps 1999, 2000 et 2001 et à l'automne 2000 et 2001, ont été analysées pour compléter le manque d'information sur la structure de la population, la relation taille-poids et la biologie reproductive du chien espagnol dans la zone étudiée. Au total, 1046 spécimens (537 mâles et 508 femelles) ont été récoltés entre 300 et 700 m de profondeur. La proportion de traits de chalut positifs a été de 55% pour les strates les plus profondes (300-700 m). La taille des spécimens variait de 10 à 50 cm LT pour les mâles et les femelles. Les jeunes spécimens de *G. melastomus* ont constitué l'essentiel des captures. Les distributions des fréquences de tailles étaient plurimodales, mais des différences significatives dans la composition de la population ont été observées en fonction des saisons et de la profondeur. L'étude de la relation taille-poids a permis de mettre en évidence une croissance isométrique.

Key words. - Scyliorhinidae - *Galeus melastomus* - MED - Southern Tyrrhenian Sea - Biology - Distribution.

The blackmouth catshark *Galeus melastomus* Rafinesque, 1810 is widespread in the whole Mediterranean Sea (Bertrand *et al.*, 2000; Relini *et al.*, 2000; Baino *et al.*, 2001; Rey *et al.*, 2002). Although its bathymetrical distribution is quite wide and ranges from 55 to 1750 m of depth (Stefanescu *et al.*, 1992; Relini *et al.*, 1999), *G. melastomus* prefers muddy bottoms between 200 and 500 m depth (Fisher *et al.*, 1987; Compagno, 1984). In the western basin, it lives between 400 and 1400 m depth (Moranta *et al.*, 1998).

In the Mediterranean, knowledge about distribution, biology and feeding behaviour of this species are available for the western (Macpherson, 1980; Carrason *et al.*, 1992; Bozcano *et al.*, 2001; Rey *et al.*, 2002) and central basin (Capapé and Zaouali, 1976, 1977; Relini Orsi and Wurtz, 1975, 1977; Sartor and De Ranieri, 1995; Tursi *et al.*, 1993; Ungaro *et al.*, 1997; Scacco *et al.*, 2002).

Notwithstanding this, the knowledge about the distribu-

tion and biology of the blackmouth catshark is limited, and no data were available for the Southern Tyrrhenian Sea. Data from five trawl surveys, carried out during spring 1999, 2000 and 2001 (MEDITS EU project: Bertrand *et al.*, 2002) and autumn 2000, 2001 (GRUND national project funded by Italian MIPAF Ministry: Relini, 1998), were used to fill the gap. These data were analysed in order to contribute towards space-time distribution, population structure, length-weight relationship, and reproductive biology of *G. melastomus*.

G. melastomus represents a high fraction of the by-catch of valuable species like aristeids (Di Natale *et al.*, 1995; Ragonese *et al.*, 2000). The high fishing pressure leads to impoverish chondrichthyan populations in all the Mediterranean Sea (Vacchi and Notarbartolo di Sciara, 2000).

The aim of this paper is to provide some biological information on the population of *Galeus melastomus* of the Southern Tyrrhenian Sea.

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MATERIAL AND METHODS

The investigated area is situated between Capo Suvero (the Calabrian coast) and Capo San Vito (the Sicilian coast) in the Southern part of the Tyrrhenian Sea (Fig. 1).

The samplings were carried out, using commercial vessels, during two different projects by means of two different trawl nets. During the spring trawl-surveys (MEDIT project), an ad hoc designed trawl net, with 20 mm of stretched mesh size was used. Otherwise a trawl net with 36 mm meshes in the cod-end was utilised for autumn surveys (GRUND project). A stratified random sampling method was adopted for both projects; the hauls were distributed among five bathymetric strata: A: 10-50 m (622 km²); B: 51-100 m (1003 km²); C: 101-200 m (1224 km²); D: 201-500 m (1966 km²); E: 501-800 m (2441 km²) (Bertrand *et al.*, 2002; Relini, 1998). The survey characteristics (hauls, date, depth range) are reported in table I.

The specimens of *G. melastomus* were weighed (to the nearest 0.5 g), counted, measured (total length (TL) recorded at 0.5 cm), and sexed directly on board. The maturity stage of the gonads was also recorded according to the Holden and Raitt's method (1974). The data coming from each survey were then joined into "spring" and "autumn", maintaining the sex separated, and represented as histograms. The few mature females recorded did not permit to calculate the length at first maturity; only the median length was calculated.

The weight-length relationship was elaborated by sex and by season, according to the formula (Sparre and Venema, 1996):

$$W = q * L^b; (q = \exp a)$$

Weights and TLs data were log-transformed and the linearised relationship fitted by least square regression, was used to calculate "a" and "b" coefficients. Student's t-test was used to compare the "b" coefficient in relation to sex and season. To test differences of mean length by sex, depth and season, one-way ANOVA analysis was used. The Length Frequency Distributions (hereafter LFD) were calculated (joint sex) by survey and graphically represented as percentage frequency per length class.

Data regarding sexual maturity, minimum, maximum and median length were calculated for each maturity stage by sex and graphically represented as box plots for each season. The sex ratio was calculated as Females (F)/Females + Males (M). Chi-squared test was applied to assess differences in sex-ratio.

Table II. - Number of hauls of *G. melastomus* specimens by sex and survey in the two depth strata. [Nombre de captures par chalutage de *G. melastomus* mâles et femelles, selon la campagne et la profondeur.]

Season	Sex	Nr. hauls	Depth 200 - 500 m (D)		Depth 500 - 800 m (E)		
			Nr. (N/h)	Mean (N/h)	Nr. hauls	Nr. (N/h)	Mean (N/h)
Spring 1999	Females	7	8		6	21	
	Males		11			48	
	Total		19	2.7		69	11.5
Spring 2000	Females	7	0		7	21	
	Males		0			12	
	Total		0	0		33	4.7
Autumn 2000	Females	13	59		13	82	
	Males		47			61	
	Total		106	8.9		143	11.0
Spring 2001	Females	7	17		7	64	
	Males		16			85	
	Total		33	4.7		149	21.3
Autumn 2001	Females	13	33		13	204	
	Males		46			211	
	Total		79	6.1		415	31.9

RESULTS

On the whole, 1,046 specimens of *G. melastomus* (537 males and 509 females) were caught between 200 and 800 m

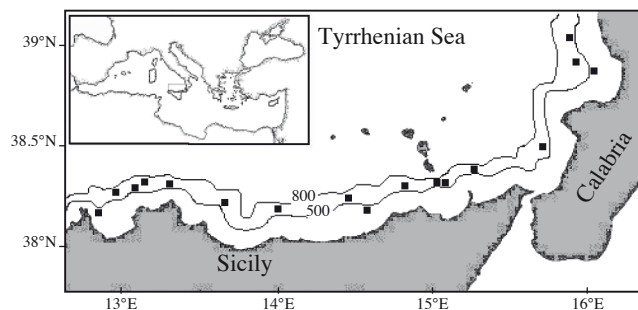


Figure 1. - Sampling area of *Galeus melastomus* (Southern Tyrrhenian Sea - Central Mediterranean), showing the trawl stations surveyed (■) and the 500, 800 isobaths. [Zone d'échantillonnage de *Galeus melastomus* (Méditerranée centrale - mer Tyrrhénienne méridionale), avec indication des chalutages (■) et des isobathes 500 et 800 m.]

Table I. - Data of sampling cruises carried out in the Southern Tyrrhenian Sea. [Données de campagnes de pêche effectuées dans la mer Tyrrhénienne méridionale.]

Survey	Year	Period	Nr. of hauls	Depth range
Medit	1999	19-25 May	28	35-662
Medit	2000	12-18 June	27	26-620
Grund	2000	12-28 September	54	17-712
Medit	2001	10-16 May	28	25-667
Grund	2001	7-27 September	76	29-680

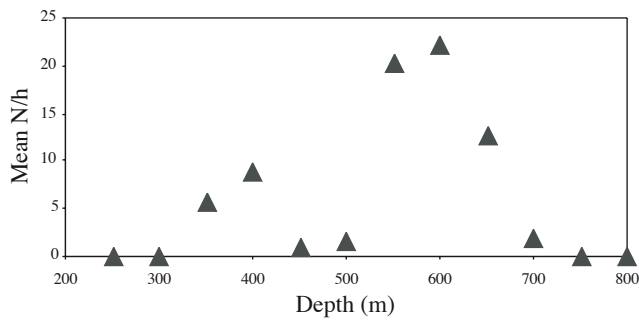


Figure 2. - Overall mean abundance (number of individuals caught per hour, N/h) recorded by sampling depth. [*Abondance moyenne (nombre d'individus capturés par heure, N/h) en fonction de la profondeur.*]

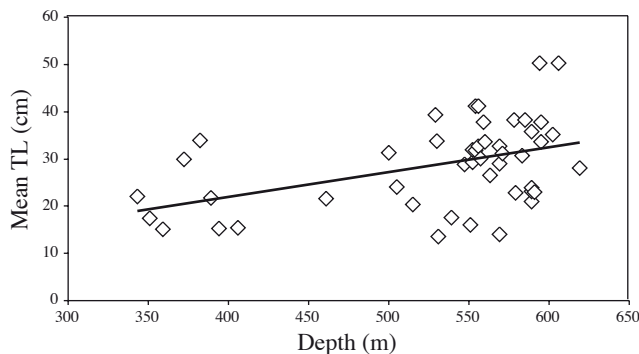


Figure 3. - Relationship between mean length of *Galeus melastomus* caught in each haul and sampling depth. [*Relation entre la taille moyenne des G. melastomus capturés lors de chaque chalutage et la profondeur.*]

depth within the whole area of the Southern Tyrrhenian Sea. In the five trawl surveys, 51 hauls out of the 93 were positive (55%) in the two deepest strata ("D" and "E").

The mean number of individuals caught in each stratum for each survey (total number divided by total hauls of each stratum) showed a clear predominance of the species in the deepest waters (500-800 m) (Tab. II). Moreover, in both season of 2001, the yields in number of the blackmouth catshark recorded a remarkable increase (stratum "E"). The highest values of the mean abundance index (N/h) by depth were recorded between 550 and 650 m of depth (Fig. 2). The overall mean length of the specimens caught in each season shows significant differences both in spring and autumn, according to the depth for both sexes ($p < 0.01$). In "D" stratum the mean TL observed, for both sexes, was lower than those observed in the deepest one (Tab. III). The different bathymetric distribution of sizes was also obtained from the results of the correlation between depth and size, which shows a significant ($p < 0.01$) increase of the mean length with increasing depth (Fig. 3).

Any significant difference of the mean length amongst the two sexes, was observed with the exception of specimens caught at 200-500 m in spring ($F = 5.1$; d.f. = 32; $p < 0.05$) and autumn 2001 ($F = 11$; d.f. = 78; $p < 0.01$), where females larger than males were recorded (Grand mean of total mean length: female = 21.34 cm, sd = 2.11; males = 19.27 cm, sd = 1.38) (Tab. III).

Significant differences ($F = 48.32$; d.f. = 1045; $p < 0.01\%$)

were observed in the mean length of the specimens (males + females) between the two seasons. The size of the specimens in autumn was smaller at any depth.

The LFDs of each survey are reported in figure 4. The length of the specimens ranged from 10 cm (for males) and 11 cm (for females) to 50 cm for both sexes. The length frequency distributions were always pluri-modal.

During spring 1999 and 2001, specimens larger than 30 cm prevailed. The most numerous cohorts corresponded to 38 cm in 1999 and 32 cm in 2001. In 2000, too few specimens were caught to identify clear modes. Otherwise during the autumn a clear predominance of specimens smaller than 30 cm was observed in 2000 (mode: 16 cm). In

Season	Sex	Depth 200 - 500 m (D)		Depth 500 - 800 m (E)	
		Mean length (cm)	s.d.	Mean length (cm)	s.d.
Spring 1999	Females	24.44	6.62	37.17	10.90
	Males	22.41	4.95	36.88	7.15
	Total	—	—	—	—
Spring 2000	Females	0	0	22.26	8.24
	Males	0	0	26.57	6.94
	Total	—	—	—	—
Autumn 2000	Females	17.96	5.15	21.73	8.23
	Males	18.96	5.37	23.34	8.57
	Total	—	—	—	—
Spring 2001	Females	21.24	5.14	30.97	8.07
	Males	18.09	2.23	32.31	7.43
	Total	—	—	—	—
Autumn 2001	Females	21.75	4.45	29.14	9.00
	Males	17.62	6.09	29.02	9.09
	Total	—	—	—	—
Grand Mean Spring	Females	22.84	2.26	30.13	7.49
	Males	20.25	3.05	31.92	5.16
Grand Mean Autumn	Females	19.85	2.68	25.43	5.24
	Males	18.30	0.95	26.18	4.02
Total Grand Mean	Females	21.34	2.11	28.25	6.44
	Males	19.27	1.38	29.62	5.22

Table III. - Mean length and grand mean length of *G. melastomus* by sex and survey in the two depth strata. s.d. = relative standard deviations values. [*Taille moyenne et taille moyenne absolue de G. melastomus par sexe et par campagne aux deux profondeurs. s.d. = valeurs relatives de déviation standard.*]

2001, the modes are overlapped due to the high number of specimens caught.

The length-weight relationships were calculated over 505 specimens (230 females and 275 males) caught during spring and autumn 2001. The overall data are reported in table IV. Any significant differences of the “b” values amongst the two sexes ($p = 0.112$) and the two seasons ($p = 0.242$) were observed. The “b” values obtained when pooling together the two seasons, being not significantly far from 3 ($p = 0.380$ and $p = 0.202$ for males and females respectively), an isometric growth was deduced for both sexes (Fig. 5).

With regards to reproductive aspects, the percentage of

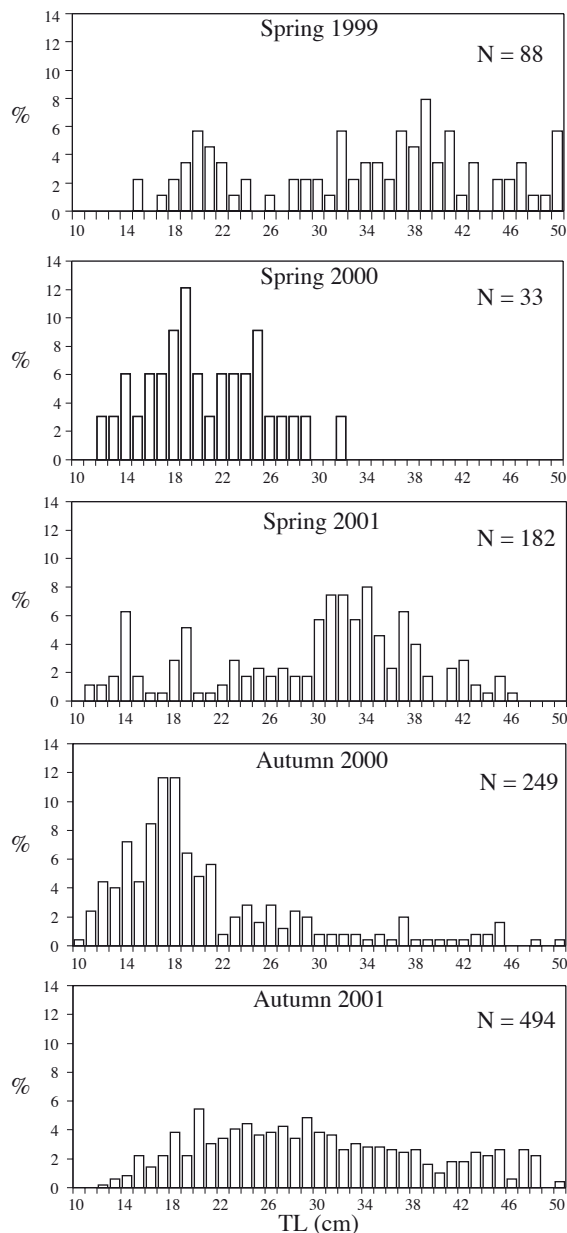


Figure 4. - Length-frequency distribution of *Galeus melastomus*. [Distribution des fréquences de taille de *G. melastomus*.]

specimens of both sexes for each maturity stages did not show sensible differences amongst the two seasons (Fig. 6). Individuals of both sexes made up the majority of the population at the first stage (immature), with average season values of 86% (F) and 79% (M) in spring and 93% (F) with 73% (M) in autumn. The pattern of median length in relation to different maturity stages is showed in figure 7. The median length was quite similar in the two seasons and the values ranged from 23 cm (stage I) to 45 cm (stage III) and from 23 to 50 cm for males and females, respectively. A slight difference was observed only in the first stage, and the median length of both sexes was smaller in autumn. It was not possible to calculate the length at first maturity, because of the scarcity of mature females caught.

A clear segregation of the sexes in relation to the depth was not observed. The sex ratio values calculated at different depth did not show significant differences (χ^2 test; $p > 0.05$).

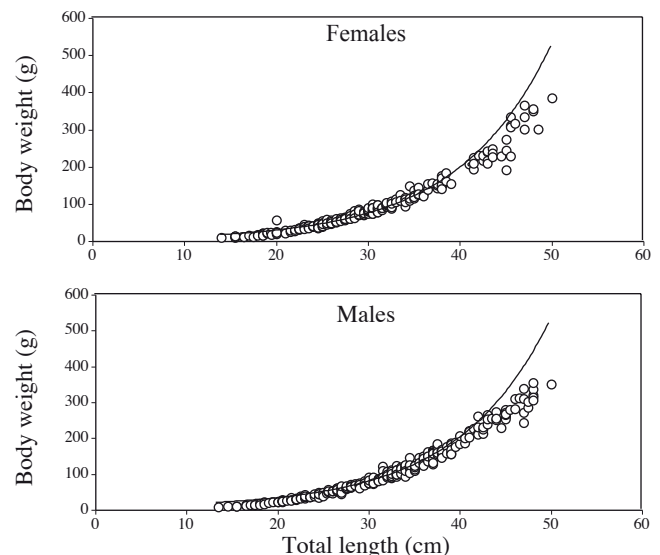


Figure 5. - Length-weight relationship for males and females of *Galeus melastomus*. [Relation taille-poids des mâles et des femelles de *G. melastomus*.]

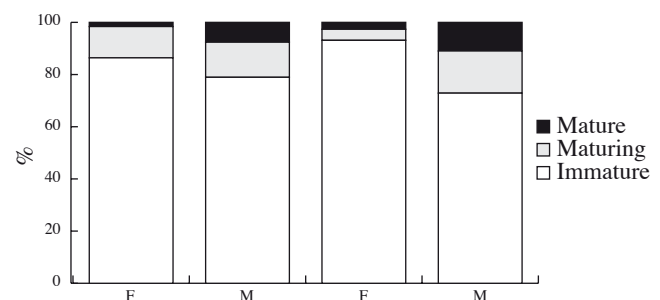


Figure 6. - Percentage of specimens of *G. melastomus* for each maturity stage by sex (F: Females; M: Males) and season (spring at left, autumn at right). [Pourcentage de *G. melastomus* pour chaque stade de maturité par sexe (F : Femelles ; M : Mâles) et par saison (printemps à gauche, automne à droite).]

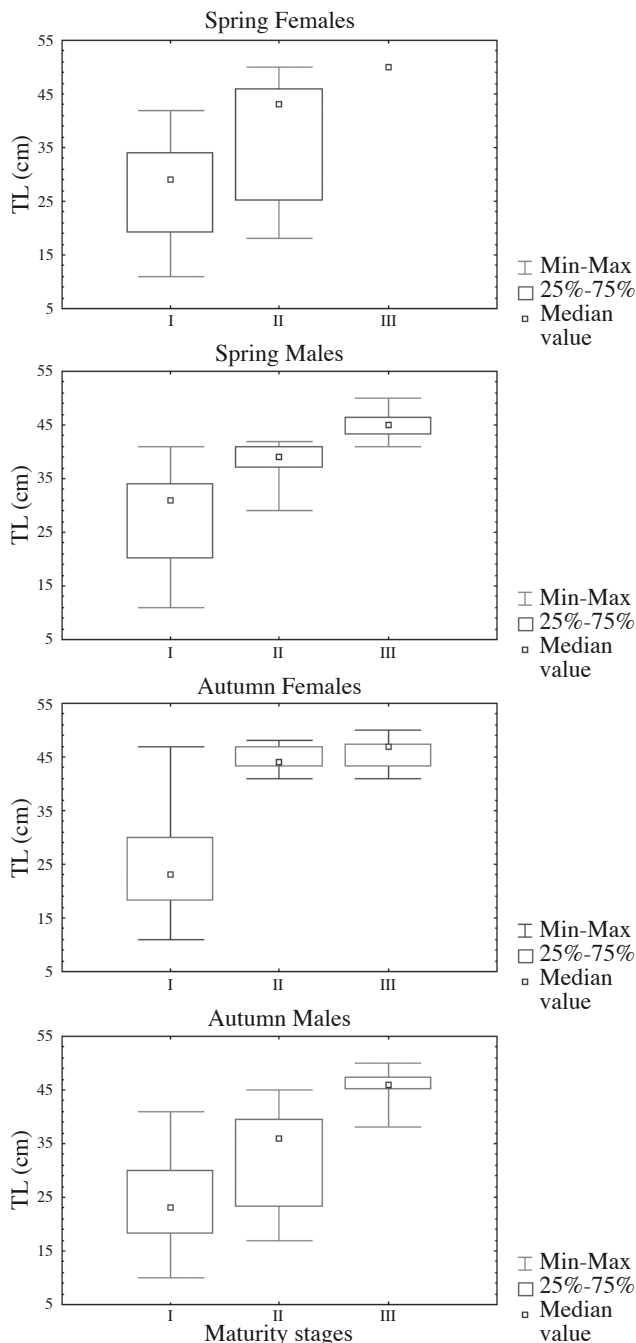


Figure 7. - Median length of *G. melastomus* in relation to different maturity stages by sex and seasons. [Taille médiane de *G. melastomus* en fonction des différents stades de maturité, par sexe et par saison.]

Table IV. - Length-weight relationship parameters estimated on *G. melastomus* specimens caught in 2001. p = probability (Student's-test) for differences between regression coefficient and value 3; p' = between two sexes. [Paramètres de la relation taille-poids estimée pour les *G. melastomus* capturés en 2001. p = probabilité (test de Student) pour les différences entre le coefficient de régression et la valeur 3; p' = entre les deux sexes.]

Sex	Number	Size range, TL (cm)	q	b	IC95%	R2	p	p'
Males	275	13.5 - 50	0.078	3.019	0.036	0.989	0.380474	0.111837
Females	230	14 - 50	0.084	2.960	0.054	0.981	0.201592	

DISCUSSION

Galeus melastomus is commonly caught on the continental slope all around the Mediterranean Sea. In Italian waters, this species has showed the highest yields amongst all the chondrichthyans (Relini *et al.*, 2000), but it has low commercial values in almost all the Italian markets. The black-mouth catshark is exposed to high fishing pressure, as it represents a good fraction of the by-catch of red-shrimp (*Aristaeomorpha foliacea* and *Aristeus antennatus*) fisheries (Ragonese *et al.*, 2000).

In the Southern Tyrrhenian Sea, the specimens were found always on slope bottoms below 300 m of depth and have a greater size than those of other Italian sites, such as the Ionian Sea (Tursi *et al.*, 1993; Maiorano *et al.*, 2000; Sion *et al.*, 2000) and the Southern Adriatic Sea (Ungaro *et al.*, 1996), where specimens smaller than 30 cm clearly prevailed. Otherwise, the Southern Tyrrhenian population seems to be similar to that of the Western Mediterranean (Alboran Sea: Rey *et al.*, 2002).

The lower mean length (< 30 cm) observed during autumn 2000 in the studied area, is already recorded during other GRUND surveys (always performed during autumn season) carried out in the Northern Tyrrhenian Sea (Relini *et al.*, 1999). The fluctuation of the length classes observed during the time, seems to be correlated to the recruitment variability during the year, as already detected in other Mediterranean areas (Tursi *et al.*, 1993).

Recruits, juveniles and adults were observed in both seasons. In the Southern Tyrrhenian Sea, as well as in other Mediterranean areas (Capapé and Zaouali, 1977; Tursi *et al.*, 1993; Rey *et al.*, 2002), *G. melastomus* showed a wide reproductive period during the year, confirmed by the presence of mature individuals and females with eggs both in spring and autumn. However, the mature specimens constitute a small fraction of the total catch, in which immature individuals of both sexes predominated.

These data reflect the fraction of the population sampled by the gear: the smaller specimens (< 100 g) are not able to avoid the capture by trawl net (Ragonese *et al.*, 2000). On the contrary, the middle-size specimens having a higher mobility and moving actively in the water column (Scacco *et al.*, 2002) can easily escape from the net.

An isometric growth was observed for *G. melastomus* in the studied area, without differences amongst seasons, according to what was recorded in the Ionian Sea (Tursi *et al.*, 1993).

The high concentrations of juveniles recorded lead to the

conclusion that a good management based on correct biological and demographic knowledge of this species, and more in general on all chondrichthyans, is needful. For example, the giant shrimp fishery, common in this area, should be regulated using more selective gears to avoid the destruction of chondrichthyans populations.

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Reçu le 17 juin 2003.

Accepté pour publication le 28 avril 2004.